Collaborative Optical-Acoustic Survey Technique (COAST)

Independent CIE Peer-Review Report of COAST Methodology

by

Luiz Mello

National Marine Fisheries Services (NMFS)
Southwest Fisheries Science Center (SWFSC)
La Jolla, California, USA
15-17 February 2012

Methodology Review Panel Members

Dr. Martin Dorn, NMFS, Alaska Fisheries Science Center
Dr. Luiz Mello, Center for Independent Experts
Dr. Gary Melvin, Center for Independent Experts
Dr. Sthéphane Gauthier, Center for Independent Experts
Dr. André Punt, Scientific and Statistical Committee, University of Washington

Collaborative Optical-Acoustic Survey Technique (COAST)

Executive Summary

Acoustic and optical surveys (COAST) were conducted in the Southern California Bight (SCB) by the National Marine Fisheries Center (NMFS) Southwest Fisheries Science Center (SWFSC) in 2003, 2004-2005, and 2007-2008, in collaboration with the Sportfishing Association of California (SAC). The main objectives of the COAST surveys are to estimate the abundance and distribution of various rockfish species in the SCB, and classify and map their sea bed habitat. The approach used consisted of conducting acoustic surveys over previously defined areas, and mapping the acoustic backscatter from rockfishes in these areas. In most cases optical surveys were conducted during the same time period as the acoustic surveys, and video and still images from cameras deployed on a remotely operated vehicle (ROV) were obtained and used to quantify the proportion of different rockfish species, as well as their size-distribution in acoustically detected mixed assemblages. The data generated by the optical surveys were then used to partition the acoustic backscatter among rockfish species, calculate their length-dependent acoustic target strengths (TS), and estimate the biomass and distribution of various rockfish species present in the surveyed areas. The COAST technique was successful in detecting and quantifying the biomass (and associated random error) and distribution of at least 22 rockfish species described for the SCB, as well as predicting and mapping their seabed habitat. However, several potentially important sources of uncertainty associated with the techniques employed were identified by the Review Panel. Specifically, the partitioning of the acoustic backscatter according to the species proportions estimated by the optical surveys; no corrections were applied to account for the proportion of fish potentially found in the acoustic dead zone (ADZ); no species-specific acoustic TS model was applied for biomass calculations; and species-specific behaviour resulting in differential detectability/availability to ROV surveys. Several recommendations were proposed for future research and data collections, and to address the main sources of uncertainty for COAST surveys.

Background

Acoustic and optical surveys (COAST) were conducted in the Southern California Bight (SCB) by the National Marine Fisheries Center (NMFS) Southwest Fisheries Science Center (SWFSC) in 2003, 2004-2005, and 2007-2008 in collaboration with the Sportfishing Association of California (SAC). The main objectives of the COAST surveys were to estimate the abundance and distribution of various rockfish species in the SCB, and classify and map their sea bed habitat. Prior to surveying, historical fishing maps and available habitat information were used in order to identify target areas for both acoustic and optical surveys. The approach used consisted of conducting acoustic surveys over previously defined areas, and mapping the acoustic backscatter from rockfishes in these areas. In most cases (> 90%), optical surveys were conducted during the same time period as the acoustic surveys, and video and still images from cameras deployed on a remotely operated vehicle (ROV) were obtained and used to quantify the proportion of different rockfish species, as well as their size-distribution in acoustically detected mixed assemblages. The data generated by the optical surveys were then used to partition the acoustic backscatter among rockfish species, calculate their length-dependent acoustic target strengths (TS), and estimate the biomass and distribution of various rockfish species present in the surveyed areas. The acoustic data were also used for predicting and mapping seabed habitat for rockfishes.

A review of the COAST methodology used for estimating biomasses and distributions of several rockfish species in the SCB, as well as the mapping of rockfishes' sea bed habitats was conducted by a Methodology Review Panel at the SWFSC Torrey Pines Court Laboratory located at La Jolla, California, between February 15-17, 2012. The Review Panel members included Dr. Martin Dorn (NMFS, Alaska Fisheries Science Center), Dr. André Punt (University of Washington), and three reviewers from the Center for Independent Experts (CIE), Dr. Luiz Mello, Dr. Gary Melvin, and Dr. Stéphane Gauthier. The Panel followed the Pacific Fisheries Management Council's Terms of Reference (ToR) for Stock Assessment Methodology Reviews.

Three main components of the COAST methodology were reviewed by the Panel, and for which recommendations were provided: acoustic estimation of rockfish biomass and distribution per species; the use of optical/visual observations to estimate the proportion and size composition of different rockfish species; and methods used for estimating uncertainty in abundance estimation.

Description of the Reviewer's Role in the Review Activities

Prior to the review, Dr. Luiz Mello read all relevant documents which were available from the FTP site at the SWFSC, La Jolla. It included all primary COAST documents from surveys conducted since 2003, assessment reports, background documents (i.e. acoustic-trawl methods, multi-frequency TS methods, multi-scattering TS methods, passive acoustic methods, uncertainty estimation), and other documents provided by CIE (e.g. ToR, SoW, schedule of milestones, deliverables).

During the Panel Review meeting, Dr. Mello reviewed and participated actively in most discussions regarding the acoustic and optical methods, which were presented by Dr. David Demer and other members of his team, requested in several occasions clarifications about the methodologies and results presented, and made suggestions pertaining to data analysis and reduction of uncertainties associated to both acoustic and optical surveys. Several of his suggestions were incorporated into the Recommendations for Future Research and Data Collections proposed by the Methodology Review Panel. In addition, the Review Panel requested that Dr. Mello provide records of the main points discussed during the meeting regarding the integration of acoustic and optical data, quantification of uncertainty, and survey design. The records were incorporated into the Report of Methodology Review Panel Meeting.

Summary of Findings for each ToR (please refer to Appendix 2 for a list of ToR)

ToR 1

The COAST surveys, data analysis methods, and results were documented in four reports, which were made available to the panel prior to the meeting. These documents provided details of the acoustic and optical methodologies used by COAST, including applicability, assumptions and uncertainties, and how acoustic and optical data were integrated and evaluated. The documents also provide overviews of rockfish biology, habitat and behaviour, as well sampling/classification techniques (acoustics/optical/ habitat), and assessment and management of rockfishes in the SCB.

The meeting discussions focused on four main issues: partitioning of the acoustic backscatter among rockfish species using information provided by the optical surveys; differential detectability/availability of rockfish species to the ROV (because of species-specific behaviour/life style, distribution preferences); extrapolation of biomass estimation into the ADZ; and estimation of variance.

Acoustic survey methodology: Sufficient information on acoustic sampling, echo-integration, sea bed and dead zone detection, sea bed classification, TS estimation, and partitioning of the acoustic backscatter associated to rockfishes was provided in the primary COAST and background documents, as well as during the meeting. Even though some of the techniques are novel, the overall acoustic methodological approach used by COAST to assess rockfish abundance (s), distribution (s) and associated sea floor habitats is comprehensive and sound, and it is consistent with acoustic assessment techniques applied to pelagic and demersal fish species elsewhere (e.g. Simmonds, 2003; McQuinn et al., 2005; Mello and Rose, 2011).

Optical survey methodology: the information available in the primary COAST documents and presented during the meeting provided a good summary of the optical surveys. However, in my view, insufficient information was provided on optical data analysis, in particular on the methodologies employed to assess rockfish species composition, how species proportions were assigned while considering the vertical distribution of the various rock fish species, and species-specific behavioural responses in the presence of

the ROV. Also, limited information was presented on the laser technique used for the measurement and validation of rockfish length. Finally, according to comments made by some of the public attending the meeting and from some NMFS/SWFSC technical/scientific staff (Santa Cruz), it seems that not all available scientific information, in particular the issues of acoustic detectability of fish near/within the ADZ, as well as fish behaviour/availability to the ROV, was considered by COAST in their assessment of rockfishes in the SCB.

ToR 2

Acoustics methods:

Acoustic surveys employed a Simrad EK 60 scientific echo-sounder, which is the reference for acoustic surveys worldwide, coupled with transducer using the correct frequencies for the depths and type/size of organisms being surveyed. The echo-sounder calibration followed standard procedures, as recommended by the manufacturer and published in the peer-reviewed literature (Jech et al. 2005). The surveyed areas were selected according to *a priori* knowledge of fish distribution and behaviour (e.g. fishing maps, diel movements, preferential habitats); this approach is useful for the allocation of sampling effort and optimization of survey time (e.g. daytime surveys only), and has been used successfully for other fish stocks (Vilhjálmsson and Carscadden, 2002; Rose, 2003; Mello and Rose, 2009). Sampling design comprised of grids of parallel transects spaced 0.1-0.4 n.mi. Considering the information available (rockfish diel movements, distribution, site fidelity, etc.), the approach used for targeted survey areas, daylight surveys, transect pattern and spacing during the acoustic surveys appear to be appropriate.

Acoustic data processing was conducted using Echoview software, which is the reference software for this type of application. The methodologies employed to estimate a length-dependent TS model for rockfishes, to partitioning acoustic backscatter attributed to rockfish species, as well as sea bed detection are straightforward and analogous to those used by previous hydro-acoustic assessments of various fish stocks (e.g. Gauthier and Rose, 2001; Mello and Rose, 2011). However, the techniques used for estimating the ADZ and potential sea bed habitats are novel, analytically sound, and have been recently published in the primary literature (Conti et al., 2005; Cutter and Demer, 2010).

Results from the acoustic analysis were used to post-stratify each survey site according to depth (shallow areas (< 150 m) and deep areas (≥ 150 m), and fish density (potentially low and high density habitats). Such approach was considered reasonable by all Review Panel members, including myself.

Optical methods:

Optical surveys were conducted subsequently to the acoustic surveys over 90% of the shallow stratum, but in approximately in 30% of the deep stratum (there is no

stratification in terms of low/high densities). Therefore, in most cases COAST surveys can be considered synoptic for the shallow water stratum.

The optical survey uses a post-stratification approach according to the results from the acoustic survey for a particular area to assess species-specific characteristics (fish densities, substrate type and use), and the estimation of the proportions and sizes of different rockfish species occurring in the surveyed area. These estimates are aimed at reducing error in rockfish biomass estimates for individual species. The main advantages of the optical survey approach are: it is non-extractive & non lethal method, it operates in untrawlable bottom, and it provides independent estimates of species proportions and length distributions. However, it is assumed that the species proportions estimated by the ROV surveys near the sea floor are similar to the species proportions in the water column, which is not directly assessed by the optical surveys. Some important and unclear aspects of the methodology employed (which may potentially affect uncertainty levels of biomass estimates) include:

(i) How representative is the estimation of different proportions of rockfish species through the water column? More than 90% of the ROV surveys were conducted at distances < 2 m from the sea floor. According to the information provided to the Review Panel, in addition to comments from the public and staff from the Santa Cruz lab, species-specific differences in vertical distribution and behavioural responses to the ROV platform are observed in several cases. Members of the COAST team indicated that rockfishes typically display herding behaviour towards the bottom during the deployment of the ROV, making the majority of fish available to the survey. This assumption is untested and needs to be validated.

(ii) Detectability/availability of various rockfish species along the horizontal plan in the presence of the ROV is also poorly understood, but such a source of variability is assumed to be negligible. The implication here is that some rockfish species could be available/assessed by the acoustic survey but not accounted for by the optical survey. The same rationale would be valid for the vertical plan (e.g. rockfish species that are typically benthic and available to the optical survey, but within the ADZ and hence not detected by the echo-sounder).

(iii) In several instances, no optical data were available for specific area/stratum/year combinations. In such cases, optical data from adjacent areas and/or different time periods were used to estimate species proportions. Such sources of variability could potentially bias the estimation of species proportions and biomass, particularly for rockfish species subject to recent declines/increases in abundance or for those species subjected to removals (e.g. sporting/commercial fishing outside protected areas). Can it be assumed that species proportions are the same in both areas, particularly for exploited species? Further investigation on this issue is advised.

(iv) Data on rockfish length measurements were obtained using two pairs of parallel reference lasers mounted on the ROV's camera platform. This is an interesting and potentially very useful technology. However, this approach has produced very limited

amount of information (number of measurements for each species) to date; as well the accuracy of the measurements has not been validated. COAST uses length-based TS models to convert the acoustic backscatter to biomass; thus the accuracy of length measurements is a key component for the acoustic estimation of fish biomass (and potentially an important source of uncertainty).

Alternative methods/recommendations:

A) Differential observation of rockfish species by ROV (q) is potentially a major issue for the COAST methodology, particularly for species contributing to a large proportion of overall biomass. There is a need to validate ROV measurements in terms of estimated proportion of different species, fish length estimation, species-specific behavioural reactions to ROV; there is also a need to establish an objective approach to decide which species will be included in the optical survey based on species-specific biology and behaviour.

Possible methodological approaches include the use of drop/still camera to validate ROV estimates. The use of still cameras moored to the sea floor and deployed at different depths would allow assessing species proportions and densities, behaviour, local vertical and horizontal distribution in a natural 'undisturbed' environment; such information could then be compared with similar measurements conducted in the same area using the ROV. Another approach would be conducting fishing and ROV surveys in areas where fishing is allowed, and then compare species composition, densities and length frequencies (this approach would require at least the knowledge of fishing gear selectivity and q); another approach is to compare optical estimates with other data sources (e.g. Sport fisheries statistics).

B) No correction for autocorrelation in acoustic sampling; samples are not independent for gregarious species, thus violating assumptions of methods based on central limit theorem (i.e. use of mean density estimate to calculate areal biomass) if not accounted for; it will impact CVs mainly. The COAST approach considers site (and not transect) as a sampling unit. This approach may be defendable from a statistical point of view, but in practical terms, one should be concerned about understanding (and modelling) the spatial variability of the data used for estimating abundance and distribution of rockfishes at relevant scales. Typically, rockfish species tend to have limited movements, gregarious distribution, and high site fidelity around sea-mounts and banks (at scales of 10s to 100s km). Thus, estimating the variance among 'independent' sites/sea-mounts/banks or the entire surveyed area may not be the best approach. I would suggest using geostatistical analysis to investigate the issue of autocorrelation in acoustic data; if autocorrelation is confirmed at relevant spatial scales (e.g. site-specific, CCA), the acoustic time-series can be de-trended and the residuals can be used to estimate unbiased indices of fish density.

C) No dead zone corrections applied; the COAST team has developed an approach that seems appropriate for estimating the ADZ. In the majority of the cases, the estimated ADZ is relatively small (< 1 m) and on average the estimated rockfish biomass within it amounted to 15%. It is recommended that the biomass estimates should include

corrections for the ADZ; estimates can also be conducted without ADZ corrections, so time-series for both estimates can be presented/considered for stock assessment.

D) TS is not species-specific; potentially a major source of uncertainty. Members of the COAST team have the expertise and infra-structure necessary to conduct research on species-specific TS estimation, and subsequent incorporation of such models into biomass estimates. TS vs. length relationships have been published for some rockfish species (Kang and Hwang, 2003; Lee, 2006; Luan et al. 2011) and those models could be incorporated into the COAST as well.

E) Species proportions (and thus biomass) are estimated through the whole study area (i.e. no separation between protected/non-protected areas). The simplest approach here would be to apply a post-stratification to the optical time series (e.g. protected/non-protected areas) and compare/test for differences in estimated proportions of rockfish species prior to estimating rockfish biomass. The same logic would apply to regions of low/high densities (stratification is only applied to the ROV in terms of shallow and deep strata); can we assume that species proportions are the same in both areas? For example, density-dependent changes in capelin behaviour were reported in Newfoundland waters during periods of low abundance in the early 1990s (Mowbray, 2002). At that time, capelin stopped conducting diel migrations and displayed a more demersal distribution year-round. Similar changes might potentially occur in areas where rockfish abundance is depleted. Applying post-stratification to the optical time series prior to estimating species proportion may prove beneficial in this case as well. In all cases, sensitivity analysis exploring the implications of the different approaches should be conducted.

ToR 3

The most critical aspect for the application of the COAST methodology in stock assessment models is the partitioning of the acoustic backscatter among the various rockfish species. Quantifying the main sources of uncertainty and bias related to the estimation of rockfish species proportions, as well as validating the several assumptions used by both acoustic and optical surveys, as identified above (ToR 2), are prerequisites for using COAST indices of abundance and distribution in stock assessment methods. In general indices of abundance with a Coefficient of Variation (CV) < 25% are necessary to produce stock assessments with acceptable confidence limits (Pope, 1982). In most cases the acoustic indices of relative abundance for all COAST surveys had CVs under the 25% threshold (Tables 5-10 in Demer et al. 2012), which is a good indicator of the precision of the estimates and applicability to stock assessment models. Curiously, the overall mean biomass estimates presented for the 43 Fathom Bank in 2003-2007 (Table 12) had in most cases CVs > 25%, suggesting considerable levels of inter-annual variability for that particular the time-series; thus the approach used to estimate abundance by combining/pooling data from multi-year surveys may not be the most appropriate. Annual biomass estimates should be sought for the years the COAST surveys were conducted.

ToR 4.

Another relevant aspect for stock assessment purposes relates to the spatial coverage of the COAST surveys vis-à-vis the distribution range of the targeted species. Considering the life traits characteristics of rockfishes (e.g. habitat associations & site fidelity, gregarious distribution, limited movement & dispersion) and historical information of catches (e.g. sport fishing), it is clear that most species tend to be associated to sea-mounts and offshore banks in the SCB. However, not all of the areas containing sea-mount and banks within the SCB were surveyed by COAST (Fig. 1, Demer et al., 2012). Not enough information was provided during the meeting or in the documents available regarding the estimation of the surface areas for each stratum (even though biomass estimates were obtained for the entire SCB region). One approach would consist in surveying one or more banks not previously surveyed by COAST and compare results (e.g. species composition, indices of relative abundance and associated CVs) with adjacent and further away sites previously surveyed by COAST. In this case, species proportions should be site-specific. The current approach used by COAST (i.e. estimating abundance for the entire SCB using indices from surveyed areas) would be justifiable if no significant differences in relative abundance and species proportions are found between areas regularly surveyed and areas not previously surveyed.

Moreover, the temporal coverage of the COAST surveys spans over a period of several months; and rockfish life traits characteristics, as described previously, indicate that movements for the majority of the species are limited and site fidelity is high. It suggests that intra-annual variability in rockfish abundance and species composition is likely low and that the survey methods are effective in detecting the appropriate seasonal timing for annual estimates of rockfish abundance (ditto for spatial scale, if no differences can be found between areas that are surveyed and not surveyed regularly). However, such assumptions may not be valid in the case of areas that are open to sport/commercial fisheries within the SCB. In such a case, rockfish abundance and species proportion might be 'modulated' by the spatial and seasonal patterns of the fisheries (at least for species that are targeted by the fisheries).

Acoustic tagging and telemetry studies with depth and position recorders can provide information on rockfish distribution, behaviour and site fidelity; and comparisons of results from COAST surveys with those from other sources (sport fishing, bottom trawl research surveys) could help identifying rockfish species for which the COAST surveys do not provide comprehensive spatial and seasonal coverage.

ToR 5

The Review Panel was successful in addressing all relevant issues in the ToRs and goals of the peer review process. There were no areas of disagreement among panellists regarding the main components of the COAST methodology being reviewed or in terms of the Panel recommendations. Specifically, the Panel proposed 15 recommendations for future research and data collections aimed at addressing the most relevant aspects of the COAST methodology: the acoustic estimation of rockfish biomass and distribution per

species; the use of optical/visual observations to estimate the proportion and size composition of different rockfish species; and methods used for estimating uncertainty in abundance estimation.

The review process and the subsequent recommendations made by the Panel were encompassing in terms of addressing all the major issues and sources of uncertainties identified in the COAST methodology, and in proposing approaches that are practical and that could be achieved within the current COAST framework, i.e. with the existing scientific expertise and knowledge, infrastructure, and survey design. Some of the main weaknesses of the proposed approaches relates to the availability/prioritization of financial and human resources and of time-lines.

Finally, this reviewer would like to echo the Panel Chair, Dr. Martin Dorn, highlighting the excellent and constructive atmosphere during the review process. Members of the COAST team and the Santa Cruz lab, as well as the attending public, showed a genuine interest in the review process. The output of this Review Panel should be helpful to inform the PFMC and its advisory bodies about the best available science for assessing the abundance and distribution of various rockfish species in the SCB.

Conclusions

The panel concluded that additional work is needed before the COAST survey can be used in stock assessment. Additional work should focus on quantifying the vertical distribution of different species of rockfish above the bottom, and the reactivity/avoidance of rockfish to the ROV. The uncertainty associated with these issues likely has a large influence on the assessment of rockfish species proportions, and consequently the estimation of the biomass and distribution of various rockfish species. The recommendations in this review, as well as those from the Review Panel Report, provide guidelines for addressing many of the uncertainties related to the COAST surveys. Notwithstanding, it is expected that the COAST methodology would be valid for many rockfish species (e.g. bentho-pelagic), and questionable or not acceptable for others (e.g. species highly reactive to the ROV or found mostly within the ADZ).

References

Conti, S.G., Demer, D.A., Soule, M.A., and Conti, J.H.E. 2005. An improved multiplefrequency method for measuring in situ target strengths. ICES Journal of Marine Science, 62: 1636-1646.

Cutter, G. R., and Demer, D.A. 2010. Multifrequency biplanar interferometric imaging. IEEE Geoscience and Remote Sensing Letters, 7: 171-175.

Gauthier, S., and Rose, G.A. 2001. The target strength of encaged Atlantic redfish (*Sebastes* spp.). ICES Journal of Marine Science, 58: 562-568.

Jech, J.M., Foote, K.G., Chu, D., and Hufnagle, L.C., Jr. 2005. Comparing two 38-kHz

scientific echosounders. ICES Journal of Marine Science, 62: 1168-1179.

Kang, D., and Hwang, D. 2003. Ex situ target strength of rockfish (*Sebastes schlegeli*) and red sea bream (*Pagrus major*) in the Northwest Pacific. ICES Journal of Marine Science, 60: 538-543.

Lee, D.-J. 2006. Target strength measurements of black rockfish, goldeye rockfish and black scraper using a 70-kHz split-beam echo sounder. Nippon Suisan Gakkaishi, 72: 644-650.

Luan, Y., Guan, C., Shi, X., and Shen, Z. 2011. The relationship between acoustic backscattering property and weight and body length of big yellow croaker and black rockfish. Progress in Fishery Science, 32: 47-52.

McQuinn, I.H., Simard, Y., Stroud, T.W.F., Beaulieu, J-L., and Walsh, S.J. 2005. An adaptive, integrated "acoustic-trawl" survey design for Atlantic cod (*Gadus morhua*) with estimation of the acoustic and trawl dead zones. ICES Journal of Marine Science, 62: 93-106.

Mello, L.G.S., Rose, G.A., Mowbray, F.K., and Koen-Alonso, M. 2011. Distribution and intensity of acoustic backscatter of key species identified in the 2008 fall bottom trawl survey in NAFO Divisions 2J3KLNO. DFO Can. Sci. Advis. Sec. Res. Doc., 2011/093.

Mello, L.G.S., and Rose, G.A. 2009. An acoustic-trawl survey of offshore over-wintering northern cod, Feb-Mar. 2008. DFO Can. Sci. Advis. Sec. Res. Doc., 2009/099.

Mowbray, F.K. 2002. Changes in the vertical distribution of capelin (*Mallotus villosus*) off Newfoundland. ICES Journal of Marine Science, 59: 942-949.

Pope, J.G. 1982. Shortcut formulae for the estimation of coefficient of variation of status quo TAC's. ICES CM, 1982/G:12.

Rose, G.A. 2003. Monitoring coastal northern cod: towards an optimal survey in Smith Sound, Newfoundland. ICES Journal of Marine Science, 60: 453-462.

Simmonds, E.J. 2003.Weighting of acoustic- and trawl-survey indices for the assessment of North Sea herring. ICES Journal of Marine Science, 60: 463-471.

Vilhjálmsson, H., and Carscadden, J.E. 2002. Assessment surveys for capelin in the Iceland-East Greenland-Jan Mayen area, 1978-2001. ICES Journal of Marine Science, 59: 1096-1104.

Appendix 1: Bibliography of materials provided for review

Primary COAST Documents

Demer, David A., Juan P. Zwolinski, George R. Cutter, Jr., Kyle A. Byers, Kevin L. Stierhoff, David Murfin, Josiah S. Renfree, Scott Mau, Thomas S. Sessions, Ken Franke, and John L. Butler 2012. The Collaborative Optical-Acoustic Survey Technique (COAST) for estimating the abundances and distributions of rockfishes, and mapping their seabed habitats. Unpublished Report. 43 p.

NOAA 2012a. 2007 Survey of Rockfishes in the Southern California Bight using the Collaborative Optical–Acoustic Survey Technique COAST07. David A. Demer (Ed.), 93 p.

NOAA 2012b. 2004 Survey of Rockfishes in the Southern California Bight using the Collaborative Optical–Acoustic Survey Technique COAST04. David A. Demer (Ed.), 95 p.

NOAA 2012c. 2003 Survey of Rockfishes in the Southern California Bight using the Collaborative Optical–Acoustic Survey Technique COAST03. David A. Demer (Ed.), 81 p.

Appendix 2: The CIE Statement of Work

Statement of Work for Dr. Luiz Mello

External Independent Peer Review by the Center for Independent Experts

Panel Review of the Collaborative Optical–Acoustic Survey Technique (COAST) for Surveying Rockfishes

15-17 February 2012

Scope of Work and CIE Process: The National Marine Fisheries Service (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer-reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by the CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. The CIE reviewers are selected by the CIE Steering Committee and the CIE Coordination Team to conduct the independent peer review of the NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer-review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: Three CIE reviewers will serve on a five-person Panel to evaluate the Collaborative Optical–Acoustic Survey Technique (COAST), developed by SWFSC's Fisheries Resources Division (FRD) for estimating the distributions and abundances of rockfishes in the Southern California Bight (SCB). However, the method could be used to survey other demersal fishes in other areas. The COAST uses historical fishing maps or other habitat information to initially define survey areas; data from ship-based multi-frequency echosounders to map the acoustic backscatter from rockfishes in these areas; and video and still images from cameras deployed on a remotely operated vehicle (ROV) to quantify the proportions of species, and their size-distribution, in acoustically-detected mixed assemblages. The optical information is used to apportion the rockfish backscatter to species, calculate their length-dependent target strengths, and estimate and map their biomasses. The optical information could be obtained using other camera platforms, e.g., submarines or autonomous underwater vehicles.

In 2003, 2004/5, and 2007/8, the FRD conducted COAST surveys, in collaboration with the Sportfishing Association of California (SAC), to estimate the distributions and abundances of rockfishes, by species, throughout the SCB. The information from these

and future surveys may be used to: improve assessments of multiple rockfish species; investigate the relationships between rockfishes and environmental factors, e.g., temperature, salinity, oxygen concentration, and depth; and scientifically evaluate the effectiveness of the Cowcod Conservation Area (CCA) and other management strategies. The Panel report will be used to guide improvements to the COAST survey and analysis methods, the resulting time series of estimated rockfish abundances and distributions, and estimates of their uncertainty. The Panel report will be considered by assessment analysts, but Stock Assessment Review (STAR) Panels will review the assessment models.

The Pacific Fisheries Management Council's (PFMC's) ToRs for the Panel review are attached in **Annex 2**. The tentative agenda of the Panel review meeting is attached in **Annex 3**. A Panel Summary Report Template is attached as **Annex 4**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. The CIE reviewers shall collectively have the working knowledge and recent experience in the application of fisheries acoustic and optical sampling methods; survey design; and stock assessment. The duties of each CIE reviewer shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein.

Location/Date of Peer Review: The CIE reviewers shall participate as independent peer referees during the panel review meeting at NOAA Fisheries, Southwest Fisheries Science Center, 3333 North Torrey Pines Court, La Jolla, California, 92037-1023, during 15-17 February 2012 in accordance with the agenda (**Annex 3**).

Statement of Tasks: The CIE reviewers shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Following selections of CIE reviewers by the CIE Steering committee, the CIE shall provide the reviewers' information (names, affiliations, and contact details) to the COTR, who will forward this information to the NMFS Project Contact (PC) no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the Reviewers. The NMFS project contact is responsible for providing the Reviewers with the background documents, reports, foreign national security clearance, and information concerning other pertinent meeting arrangements. The project contact is also responsible for providing the STAR Panel Chair (Chair) with a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When a CIE reviewer who is a non-US citizen participates in a meeting at a government facility, the NMFS project contact is responsible for obtaining a Foreign National Security Clearance for that reviewer. For the purpose of their security clearances, the reviewer shall provide requested information (e.g., name, contact information, birth date, passport number, travel dates, and country of

origin) to the project contact at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations (available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/sponsor.html).

Pre-review Background Documents: Two weeks before the review, the NMFS project contact will electronically send to the reviewers, by email or FTP, all necessary background information and reports for the panel review. If the documents must be mailed, the project contact will consult with the CIE on where to send the documents. The reviewers shall read all documents in preparation for the panel review, for example:

- documents on current survey methods, in particular, related to ichthyoplankton and hook-and-line sampling of rockfishes, and landings data;
- documents on SWFSC COAST surveys conducted since 2003;
- documents from past panel reviews of rockfish sampling methods;
- documents from STAR panel reviews of rockfish assessments, and;
- other documents, including the ToR, SoW, agenda, schedule of milestones, deliverables, logistical considerations, and PFMC's ToR for Groundfish Stock Assessment Methods Reviews.

Each CIE reviewer is responsible only for the pre-review documents that are delivered to that reviewer in accordance to the SoW scheduled deadlines specified herein. Any delays in submission of pre-review documents for the CIE review will result in delays with the CIE review process, including a SoW modification to the schedule of milestones and deliverables.

Panel Review Meeting: Each CIE reviewer shall conduct the independent review in accordance with the SoW and ToRs. **Modifications to the SoW and ToR cannot be made during the review, and any SoW or ToR modification prior to the review shall be approved by the COTR and CIE Lead Coordinator.** Each reviewer shall actively participate in a professional and respectful manner as a member of the Panel, and their review tasks shall be focused on the ToRs as specified in the contract SoW.

Respective roles of the reviewers and Chair are described in **Annex 2** (see p. 6-8). Each reviewer will serve a role that is equivalent to the other panelists, differing only in the fact that he/she is considered an "external" member (i.e., outside the PFMC's membership and not involved in management or assessment of west coast rockfishes). Each reviewer will serve at the behest of the Chair, adhering to all aspects of the PFMC's ToR as described in **Annex 2**. The Chair is responsible for: 1) developing an agenda; 2) ensuring that panel members (including the reviewers) and FRD follow the ToR; 3) participating in the review of the methods (along with the reviewers); and 4) guiding the Panel (including the reviewers) and FRD to mutually agreeable solutions.

The NMFS project contact is responsible for any facility arrangements (e.g., conference room for panel meetings or teleconference arrangements). The CIE Lead Coordinator can contact the project contact to confirm any meeting facility arrangements.

Contract Deliverables - Independent CIE Peer-Review Reports: Each CIE reviewer shall complete an independent CIE-review report in accordance with the SoW, i.e., in the required format as described in **Annex 4**, and addressing each ToR as described in **Annex 2**.

Other Tasks – Contribution to Summary Report: The reviewers will assist the Chair with contributions to the Summary Report. The CIE reviewers are not required to reach a consensus, and should provide a brief summary of their views on the findings and conclusion reached by the review panel in accordance with the ToRs (**Annex 1**).

Specific Tasks for CIE Reviewer: The following chronological list of tasks shall be completed by the CIE reviewers in a timely manner, as specified in the **Schedule of Milestones and Deliverables**:

1) Prepare for the panel review by reading the background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Participate in the panel review meeting in La Jolla, California during the dates specified in the schedule of milestones and deliverables herein.
3) Conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4) Submit, no later than 3 March 2012, an independent peer review report addressed to the "Center for Independent Experts," to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and to Dr. David Die, CIE Regional Coordinator, via email to ddie@rsmas.miami.edu. Each CIE reviewer shall write their report using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: The CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

January 20, 2012	The CIE sends the Reviewer's contact information to the COTR, who forwards it to the NMFS Project Contact.
Feb 1, 2012	The NMFS Project Contact sends the pre-review documents to each reviewer.
Feb 15-17, 2012	Each Reviewer participates in the panel meeting and conducts an independent review.
March 3, 2012	Each CIE reviewer submits their draft report to the CIE Lead Coordinator and CIE Regional Coordinator.
March 17, 2012	Following any necessary revisions and approval by the CIE Steering Committee, the CIE submits the CIE reports to the COTR.
March 24, 2012	The COTR distributes the final reports to the NMFS Project Contact and the regional Center Director.

Modifications to the Statement of Work: Requests to modify this SoW must be made through the COTR who submits the modification for approval to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the CIE within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToR of the SoW as long as the role and ability of each Reviewer to complete the SoW deliverable in accordance with the ToRs and the deliverable schedule is not adversely impacted. The SoW and ToRs cannot be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, they shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via email the contract deliverables (the CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards. Each CIE report shall: (1) have the format and content in accordance with Annex 1; (2) address each ToR as specified in Annex 2; and (3) be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon notification of acceptance by the COTR, the CIE Lead Coordinator shall send via email the final CIE reports in pdf format to the COTR. The COTR will distribute the approved CIE reports to the PC, and the regional Center Director.

Support Personnel:

William Michaels, Program Manager, COTR
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-713-2363 ext 136

Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
10600 SW 131st Court, Miami, FL 33186
shivlanim@bellsouth.net Phone: 305-383-4229

Key Personnel:

Dr. David Demer, FRD (**Project Contact**)
National Marine Fisheries Service, Southwest Fisheries Science Center
8604 La Jolla Shores Dr., La Jolla, CA 92037

David.Demer@noaa.gov Phone: 858-546-5603

Dr. John Butler, FRD
National Marine Fisheries Service, Southwest Fisheries Science Center
8604 La Jolla Shores Dr., La Jolla, CA 92037
John.Butler@noaa.gov Phone: 858-546-7149

Dr. Russ Vetter, Director, FRD
National Marine Fisheries Service, Southwest Fisheries Science Center
8604 La Jolla Shores Dr., La Jolla, CA 92037
Russ.Vetter@noaa.gov Phone: 858-546-7125

Appendix 3: Panel Membership

Luiz Mello is a biologist at the DFO Northwest Atlantic Fisheries Centre in St. John's, Newfoundland, Canada. He holds degrees in Oceanography (B.Sc., University of Rio Grande), Marine Resources Management (M.Sc., University of Quebec) and Biology (Ph.D., Memorial University of Newfoundland). Since 1990 he has conducted research in fisheries biology and resource assessment, as a graduate student, post doctoral fellow and professionally. Most of his research has focused on relating life history traits of fishes (e.g., reproduction, feeding, distribution and migration) to population dynamics and techniques used in stock assessment (fisheries acoustics, bottom trawl surveys, electrofishing), and fisheries conservation. He has conducted this research with important commercial fish species in Atlantic Canada including cod, herring, capelin and salmon, as well as marine fish species considered at risk of extirpation or extinction, including bluefin tuna, and different skates and wolffish species of the North Atlantic.

Martin Dorn is a Fisheries Research Biologist at the Alaska Fisheries Science Center, NOAA Fisheries, in Seattle, USA. He holds a M.Sc. in Biomathematics and a Ph.D. in Fisheries from the University of Washington. Martin has been involved in research on management strategy evaluations to evaluate impacts of climate and ecosystem change, modelling fishing behaviour, and applying Bayesian methods to resource management problems. His current research focuses on the Bayesian meta-analysis of fish populations, and the development of cooperative research programs to address fisheries management issues. Martin leads the stock assessment team for walleye pollock in the Gulf of Alaska. He has been a member of the ICES working group on the ecosystem effects of fishing activities (WGECO) and the ICES study group on the use of acoustics on fishing vessels. He is Chair of Scientific and Statistical Committee (SSC) of the Pacific Fisheries Management Council and is an Affiliate Associate Professor at the School of Aquatic and Fishery Sciences at the University of Washington, Seattle.

Stéphane Gauthier is a research scientist at the DFO Institute of Ocean Science in Sidney, British Columbia, Canada. He received a B.Sc. and M.Sc. from the University of Montreal and a Ph.D. from Memorial University of Newfoundland (2001) where he worked on the acoustic properties and shoaling behavior of Atlantic redfish (Sebastes sp.). Stéphane did postdoctoral studies at the School of Aquatic and Fisheries Science at the University of Washington and at the University of Montreal. Before joining Fisheries and Oceans Canada in 2011, he spent 5 years as a fisheries scientist at the National Institute of Water and Atmospheric research (NIWA) in New Zealand where he worked on a wide range of projects spanning from the Antarctic Ocean to the Arabian Sea. Stéphane has considerable experience using acoustics and complementary technologies to address ecological issues in both marine and freshwater habitats.

Gary D. Melvin is a Research Scientist at the DFO St Andrews Biological Station in St Andrews, New Brunswick Canada. He holds a M.Sc. from Acadia University and a Ph.D. in Fisheries Biology from the University of New Brunswick. Melvin is currently involved in acoustic research and stock assessment of small pelagic species. Currently he is Chair of the ICES North Sea Technical Working and a member of the Advice Drafting group

for all North Sea assessed fish stocks. Between 2004 and 2006 he was a scientific advisor on stock assessments and acoustics to the New Zealand Seafood Industry Council. He is also an associate partner in the EU multi-institutional forage initiative (FACTS). His recent research efforts are focused on the improvement of biomass estimates using split-beam and multi-beam acoustic technology, and the adaptation of acoustic technology to monitor the distribution and abundance of fishes in the vicinity of submerged turbine structures for environmental impact assessment and for compliance and effects monitoring. He has been a long standing member of the ICES Fisheries Acoustics Science and Technology (FAST) working group, and a major contributor to the ICES and the FAO report on the use of acoustic on commercial fishing vessels as scientific platforms.

André E. Punt is a Professor and Associate Director of the School of Aquatic and Fishery Sciences at the University Washington, Seattle. He received his B.Sc, M.Sc and Ph.D. degrees in Applied Mathematics at the University of Cape Town, South Africa. Before joining the University of Washington, André was a Principal Research Scientist with the CSIRO Division of Marine and Atmospheric Research. His research interests include the development and application of fisheries stock assessment techniques, bioeconomic modelling, and the evaluation of the performance of stock assessment methods and harvest control rules using the Management Strategy Evaluation approach. He has published over 190 papers in the peer-reviewed literature, along with over 400 technical reports. André is currently a member of the Scientific and Statistical Committee (SSC) of the Pacific Fishery Management Council and chair of its Coastal Pelagic Species subcommittee, the Crab PLAN Team of the North Pacific Fishery Management Council, and the Scientific Committee of the International Whaling Commission.

Appendix 3: Review Panel Agenda

Panel Review of The Collaborative Optical–Acoustic Survey Technique (COAST) for Surveying Rockfishes

15-17 February 2012

Day 1

0.0 Orientation (Dorn/DeVore) (1/2 hr)
1.0 Overview of rockfish biology, habitat, behavior (Butler) (1 /2 hr)
2.0 Overview of rockfish sampling, assessment, and management (Butler) (1/2 hr)
3.0 Overview of optical surveys for (Butler) (1 1/2hr)
- 3.1 Optical sampling devices and platforms
  - 3.1.1 Video, still, stereo, high-definition cameras
  - 3.1.2 Divers, submarines, AUVs, and ROVs
- 3.2 Sampling, classifying, and mapping seabed habitats of rockfishes
- 3.3 Estimating species mixtures and their sizes
- 3.4 Estimating biomasses and distributions of rockfishes, by species
- 3.5 Estimating systematic and random measurement and sampling errors
- 3.6 Summary of the advantages and limitations of optical sampling methods

4.0 Overview of acoustic-trawl surveys for estimating the abundances, distributions, and demographics of epi-pelagic fishes, and classifying and mapping their oceanographic habitat (Demer) (1/2 hr)
- 4.1 Acoustic sampling devices and platforms
  - 4.1.1 Multi-frequency echosounders
  - 4.1.2 Ships
- 4.2 Sampling, classifying, and mapping oceanographic habitats of epi-pelagic fishes
- 4.3 Estimating species mixtures and their sizes
- 4.4 Estimating biomasses and distributions of epi-pelagic fishes, by species
- 4.5 Estimating systematic and random measurement and sampling errors
- 4.6 Summary of the advantages and limitations of acoustic-trawl sampling methods

5.0 Description of acoustic-optical surveys for estimating the abundances, distributions, and demographics of rockfishes, and classifying and mapping their seabed habitats (Demer) (3 hr)
- 5.1 Acoustic sampling devices and platforms
  - 5.1.1 Multi-frequency echosounders
  - 5.1.2 Ships and AUVs
- 5.2 Sampling, classifying, and mapping seabed habitats of rockfishes
- 5.3 Estimating species mixtures and their sizes (refer to 3.3)
- 5.4 Estimating biomasses and distributions of rockfishes, by species
- 5.5 Estimating systematic and random measurement and sampling errors
- 5.6 Summary of the advantages and limitations of optical-trawl sampling methods

6. Panel Requests to Analytical Team on Day 1 Topics (Dorn) (1/2 hrs)

Day 2

7.0 Applications of the COAST (Collaborative Optical-Acoustic Survey Technique) (Demer) (2 1/2 hrs)
- 7.1 COAST Surveys
  - 7.1.1 2003 pilot survey
  - 7.1.2 COAST 2004 survey of the SCB
  - 7.1.3 COAST 2007 survey of the SCB
- 7.2 COAST survey estimates of rockfishes by species and strata
  - 7.2.1 Behaviors
  - 7.2.2 Distributions
  - 7.2.3 Seabed habitats
  - 7.2.4 Abundances and estimates of error

8.0 Utility of the COAST estimates for assessments of rockfishes (Demer) (1/2 hr)
- 8.1 Using estimates of rockfish behavior, demographics, distribution, and abundance, and maps of their seabed habitat
  - 8.1.1 Species for which the method is appropriate
  - 8.1.2 Scaling survey density estimates to population level
- 8.2 Future work

9.0 Panel Requests to Analytical Team on Day 2 Topics (Dorn) (1/2 hrs)

10.0 Review Work Assignments and start drafting report (Dorn) (4 hrs)

Day 3:

11.0 Review Work Assignments and continue drafting report (Dorn) (8 hrs)